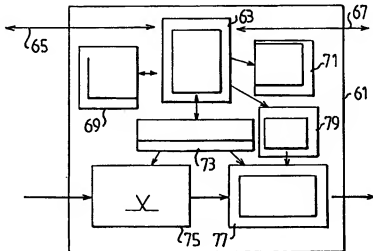




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/SE98/00296 (22) International Filing Date: 19 February 1998 (19.02.98) (30) Priority Data: 9700599-5 20 February 1997 (20.02.97) SE (71) Applicant (for all designated States except US): TELEFON- AKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE). (72) Inventor; and (75) Inventor/Applicant (for US only): FALCHI, Michela [IT/SE]; Oxelvägen 14, S-191 43 Sollentuna (SE). (74) Agents: HERBJØRNSEN, Rut et al.; Albihs Patentbyrå Stockholm AB, P.O. Box 3137, S-103 62 Stockholm (SE).</p>		<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>

(54) Title: RESOURCE RESERVATION IN ATM NETWORKS



## (57) Abstract

A method and an apparatus are disclosed which will allow the use of ATM switches in Internet type networks without the need for translation between protocols. According to the invention, this is achieved by providing the ATM switches to be used in such networks with resource reservation protocol (RSVP) means (63) similar to the ones used in hosts and conventional routers. When a request for resources is made, the RSVP means communicate with the means (69, 71, 73, 79) for admission control and connection management to determine whether or not the requested resources can be reserved. The RSVP means of all nodes in a network communicate with each other to reserve resources to ensure a specified quality of service for each connection.

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## RESOURCE RESERVATION IN ATM NETWORKS

The present invention relates to ATM switches and in particular to the use of such switches for data communication.

5

**Background**

To increase the effective bandwidth in data communications networks, increasing use is being made of ATM switches to perform the routing function in such networks. In this way, a packet switched network with large bandwidth is achieved.

- 10 However, the efficiency of these networks depends on how well the internet protocols can take advantage of the capabilities of the ATM to guarantee a certain quality of service.

- ATM will be particularly useful for transmitting real-time data and multimedia applications, which are currently being used to an increasing extent in the Internet and in other networks. This requires the use of Constant Bit Rate (CBR) or real time Variable Bit Rate (rt-VBR) traffic in the network.

Resource Reservation Protocol - RSVP

- 20 The Internet network currently used offers a simple service model based on best-effort service. The requests are handled on a first-come first-serve basis, as fast as the capacity in the network will allow. This works well for applications that are not time-critical, such as e-mail, retrieval of files or accessing the world wide web. In recent years, new applications have been developed, in particular real-time applications such as remote video and multimedia. If the Internet is to provide the sufficient quality of service for these applications, the service model must be able to reserve resources along the whole connection. To meet these new demands, among other things, the Resource Reservation Protocol (RSVP) is designed to support predictive service while still allowing the existing best effort service.

30

The principles of RSVP are the following:

Flow specification: A flow is defined as a sequence of packets sent from a particular source to one or more destinations. The flow is conveyed through a particular path with specific demands on the quality of service. The specification of a flow is made when the source declares the traffic characteristics of the flow it wishes to generate and the network can define the quality of service to be assigned to that flow.

Resource reservation: The network must be able to reserve and maintain the resources reserved on each link along the path. The resources in question are the ones where several flows can compete: the bandwidth of the link, and the occupancy of buffers.

Admission control: In order to maintain the requested quality of service for flows already active, the network must be able to deny new reservation requests that can affect the performance of already operating flows.

Packet scheduling: Within each host or router in the network there must be a scheduler to decide which packet is to be transmitted first. The decision is related to the quality of service of the flow to which the packet belongs.

Applications request the quality of service required from the RSVP. The RSVP informs each router along the communication path about the request.

The RSVP reservation request originates at the receiving end but the actual quality of service control takes place at the sender's end. The reservation requests are passed on in the reverse flow direction, from the receiver to the sender. At each intermediate node, a decision is made about reservation of resources. The request is passed to the admission control. If the reservation is not allowed an error message is sent to the receiver or receivers. If the request is accepted, the desired quality of service parameters are set in the packet scheduler and the packet classifier parameters are set according to the filter specifications received. The reservation request is forwarded upstream to the sender from which data is to be received.

RSVP introduces the connection-oriented approach in the Internet architecture, i.e. reserving and allocating resources for a particular flow. The traffic characteristics of a flow may depend on the type of application associated with the flow.

5

In order to fulfil the RSVP requests routers must provide more advanced scheduling mechanisms than just to serve the first arriving packet first. The implementation of queues and fair transmission of packets from all flows in a conventional router is difficult because IP packages are long and have variable length. ATM is the only  
10 switching technology that has been developed to support switching of different traffic types using the same resources and guaranteeing a certain quality of service. The new generation of ATM switches has reached the optimal level of isolation among connections with different traffic characteristics sharing the same resources, thus ensuring that each virtual connection gets the bandwidth it should have.

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#### ATM Service Categories and Quality of Service

Three principal parameters are used to specify the quality of service in ATM (Asynchronous Transfer Mode):

Cell Transfer Delay (CTD): The maximum end-to-end cell transit time, including  
20 both the transmission delay and the queuing delay.

Cell Delay Variation (CDV): The range of delays experienced by the cells of a connection.

Cell Loss Rate (CLR): The number of lost cells divided by the total number of transmitted cells.

25

The ATM Forum has defined the following five service categories with different requirements on the quality of service parameters.

Constant Bit Rate (CBR): Supports real-time transmission of for example voice and video. The ATM network is configured to provide a constant bandwidth, which is  
30 available for the whole duration of the connection.

Real Time - Variable Bit Rate (rt-VBR): Suitable for voice and video. Supports statistical multiplexing for real time sources.

Non-real Time Variable Bit Rate (nrt-VBR): Suitable for non-real time applications.

- 5 Available Bit Rate (ABR): Suitable for non-real time applications. Does not require a specific amount of bandwidth or specific delay constraints. This class of service aims to use the spare capacity available when the high-priority connections have been served.

Unspecified Bit Rate (UBR): Suitable for low-priority non-real time applications. No quality of service is guaranteed.

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The crucial task of an ATM switch is to ensure that the specified quality of service is achieved. To ensure this, the new generation of ATM switches is provided with enhanced buffer scheduling mechanisms, to guarantee that each virtual connection is given the bandwidth it should have.

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The Internet Engineering Task Force (IETF) is an association of companies working with telecommunications and data communication, to develop solutions for the Internet. The IETF is currently working to give an overall approach for interoperating of RSVP protocol and ATM User Network Interface (UNI) signalling.

20

The starting point is the classical IP network using ATM switches where hosts are connected to ATM networks, or IP subnets, and the communication between separate IP subnets is achieved with routers.

- 25 This solution for the internet traffic keeps the two different protocol stacks: the Internet Protocol and the connection-oriented ATM signalling. With this solution translation is needed between the Internet Protocol and the ATM protocol. This solution also results in duplicated functions, primarily routing and addressing, and a less effective use of the network resources. For a host or a router in this network, the ATM network is only seen as a "cloud". Each ATM exchange is not seen; therefore
- 30 the router cannot use the network resources efficiently.

Using ATM switches in an internet type network raises some specific interworking problems between RSVP and ATM signalling:

- 5 - ATM signalling is source oriented whereas RSVP is receiver oriented. In ATM signalling, the source is responsible for the establishment of the point-to-point or point-to-multipoint virtual connections.
- The establishment of connections with ATM signalling does not provide heterogeneous quality of service objectives at the leaves of the point-to-multipoint  
10 connections.
- ATM signalling fixes the quality of service for the entire duration of the connection while RSVP can change the reserved quality of service at any time because of the soft state of the reservation.

15

#### Summary of the Invention

It is an object of the present invention to achieve a network for data communication using the Internet Protocol and allowing a specified quality of service as requested using the ATM hardware platform.

20

It is another object of the invention to achieve a network using the Internet Protocol and using the possibilities offered by an ATM hardware platform to allow for real time data communication.

- 25 It is another object of the invention to overcome the above mentioned problems associated with the use of the RSVP in an ATM signalling based network.

According to the invention, this is achieved by discarding one protocol stack, the ATM control plane and to use the IP stack together with the RSVP control protocol  
30 to control the ATM switch.

The main advantage of the invention is that it allows for more efficient use of ATM resources in an internet type network.

### Brief Description of the Drawings

- 5 In the following, the invention will be discussed in more detail, with particular reference to the drawings, on which
- Figure 1 is a schematic view of a data communications network involving ATM switches according to prior art;
- Figure 2 shows the interaction of a host and a router using the Resource Reservation
- 10 Protocol;
- Figure 3 shows an ATM switch equipped with an RSVP unit according to the invention; and
- Figure 4 shows a connection between two hosts, including ATM switches according to the invention.

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### Detailed Description of Embodiments

- Figure 1 shows an example of a data communications network according to prior art. The network comprises a first 1 and a second 3 local network, both comprising ATM switches and connected to each other via a router 5. A first host 7 is connected to the
- 20 first local network, and a second host 9 is connected to the second local network 3. The router 5 and the hosts 7, 9 comprise RSVP means, but these are unable to control the ATM networks directly. Data is passed from the first host 7, through the first ATM network 1 to the router 5, which transmits the data to the second ATM network 3, through which the data is transmitted to the second host 9. The router 5
- 25 and the hosts 7, 9 do not see the architecture of the ATM networks and are unable to make decisions about how the ATM network resources should be used.

- Figure 2 shows how a host 21 and a router 23 cooperate, in a known manner, to reserve and allocate resources for a specific connection. The host 21 contains an
- 30 RSVP means 25, which co-operates with the application 27 hardware and software from which the data to be transmitted originates. The application 27 and the RSVP



- means 25 are also connected to the packet classification means 29, which determines the route of the packet. The packet classification means 29 forwards the packets received from the application 27 to the packet scheduler 31. The RSVP means 25 is also connected to the police control means 33 and to the admission control means 35. The admission control means 35 decides if a new resource reservation request is to be granted or not. This is necessary to guarantee the specified quality of service to the connections already set up. The police control means 33 supervises the traffic to enforce the compliance of all connections to the agreed quality of service.
- 10 The RSVP means 25 is connected to a similar RSVP means 37 resident in the router 23. The RSVP means 37 is connected to a packet classification means 39 and a packet scheduling means 41 similar to the ones 29, 31 found in the host 21. The RSVP means 37 is also connected to a router process means 43, a police control means 45 and an admission control means 47 similar to the ones found in the host.
- 15 Figure 3 shows an ATM switch 61 according to the invention. The switch 61 comprises an RSVP means 63, similar to the RSVP means 25, 37 in the host 21 and the router 23 of figure 2. The RSVP means 63 receives resource reservation requests from the RSVP means of other ATM switches, routers or hosts to which it is
- 20 connected via at least one connection 65, 67. The RSVP means 63 is connected to a router process means 69 and to a police control means 71. The RSVP means 63 is also connected, via a VC management means 73, to the ATM switch core 75 and to a packet scheduling means 77. The RSVP means 63 is also connected to the packet scheduling means 77 via a Connection Admission Control (CAC) means 79. The
- 25 CAC means 79 controls the actions taken by the network at the set-up phase of a connection in order to accept or reject an ATM connection.

As can be seen, some units are the same in the ATM switch as in a router or host, namely the router processing means 69 and the police control means 71. Instead of

30 the admission control means found in the host or router, the RSVP means is connected to the CAC means 77, and instead of the packet classification means and

the packet scheduler, the RSVP means is connected to the VC management means 73. Because of this, the RSVP means to be used in an ATM switch must be adapted with new interfaces to the units that are unique for the ATM switch.

- 5 Figure 4 shows an example of a connection in a data communications network according to the invention. The network architecture in this figure is only an example. Any combination and any number of ATM switches, routers and hosts is possible.
- 10 The network comprises a first 91 and a second 93 ATM switch, each comprising an RSVP means 95 and 97 respectively. Both ATM switches 91, 93 are connected to a router 99, also comprising an RSVP means 101. The RSVP means 95, 97 of both ATM switches 91, 93 are connected to the RSVP means 101 of the router 99. A first host 103 also comprising an RSVP means 105 is connected to the first ATM switch
- 15 91. The RSVP means 105 of the first host 103 is connected to the RSVP means of the first ATM switch. A second host 107, also comprising an RSVP means 109, is connected to the second ATM switch 93. The RSVP means 109 of the second host 107 is connected to the RSVP means 97 of the second ATM switch. The router has ATM ports 111, 113 and the first 103 and second 107 host have similar ATM ports
- 20 115 and 117 respectively, for receiving and transmitting ATM cells.

When the second host 107 wishes to receive data from the first host, the RSVP means 105 of this host sends a request for resources to the RSVP means 97 of the ATM switch 93 to which it is connected. This RSVP means 97 uses information

25 from the connection admission control means of this switch 93 to grant or deny the requested resources. If the resources are granted, the request for resources is forwarded to the RSVP means 101 of the router 99, which handles the request and determines whether or not the resources may be granted. If so, the request is forwarded to the RSVP means 95 of the first ATM switch 91.

The RSVP means 95 in its turn determines whether or not the requested resources can be granted in the first ATM switch 91 and, if this is the case, forwards the request to the RSVP means 105 of the first host 103. If the requested resources are granted for all links in the connection, the connection is set up. If the requested  
5 resources cannot be granted for all links, an error message is sent to the second host 107, from which the request for resources originated.

## Claims

1. An ATM switch (61) comprising an ATM switch core (75), a VC scheduler (77), CAC means (79) and VC management means (73), router means (69) and traffic  
5 supervision means (71), said CAC means (79) being connected to the ATM switch core (75) and to the VC scheduler (77), and said CAC means (79) being connected to the VC scheduler (77), said switch being characterized in that it comprises at least one RSVP means (73), which is connected to at least the CAC means (79) and the VC management means (73), for controlling its functions for admission control  
10 and for assignment of VP/VCs.
2. Data communication network comprising at least two nodes through which data is transmitted between at least two hosts, characterized in that at least one of the nodes is an ATM switch according to claim 1.
- 15 3. Data communication network comprising at least two interconnected nodes for ensuring a specified quality of service in data communication between at least two hosts, each host being connected to a node in the network, at least one node being an ATM switch (61; 91, 93), said network being characterized in that
- 20 - All nodes, including the ATM switch, are provided with essentially the same kind of resource reservation means (25, 37, 63);
- Each resource reservation means (25, 37, 63) is connected to the means (33, 35, 45, 47, 71, 73, 79) controlling the use of resources in the network node to which it belongs;
- 25 - Each resource reservation means (25, 37, 63) is connected to the resource reservation means of all nodes from which the node to which it belongs can receive and/or transmit payload data.
4. Data communication network according to claim 3, characterized in that the  
30 resource reservation protocol used is the RSVP as defined by the IETF.

5. Method for ensuring a specified quality of service in a data communication network comprising at least two interconnected nodes through which data is transmitted between at least two hosts, each connected to a node in the network, at least one node being an ATM switch (61; 91, 93), and each node in the network comprising means of essentially the same type for resource reservation, characterized in that the following steps are performed for each node that takes part in the connection:
- The resource reservation means of a node that wishes to receive data informs the resource reservation means of a second node in the network, directly connected to the first node, about the desired bandwidth and other quality of service;
  - The resource reservation means of the second node determines whether or not it can provide the requested quality of service under the current circumstances;
  - If the requested quality of service can be provided, the resource reservation means of the second node informs the resource reservation means of a third node, which in turn determines whether or not the requested quality of service can be provided.
6. Method according to claim 5, characterized in that the resource reservation means comprised in each node is an RSVP means as defined by the IETF.

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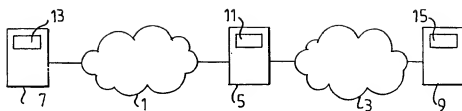


FIG.1  
PRIOR ART

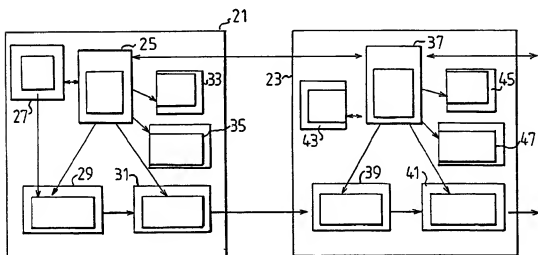


FIG.2

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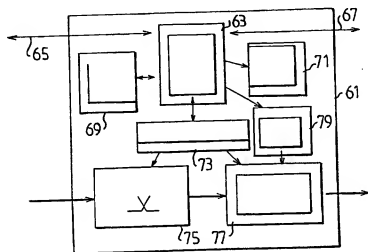


FIG. 3

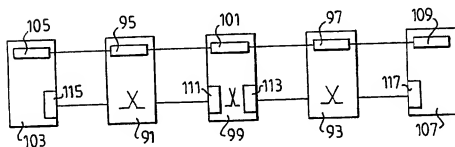


FIG. 4

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 98/00296

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 11/04, H04L 12/56

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q, H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5519689 A (YOUNG-II KIM), 21 May 1996 (21.05.96), column 17 - column 18, claims 1,2 --	1,2
X	Computer Networks and ISDN Systems 28, Volume, 1996, Alexander Schill et al, "Internetworking over ATM: Experiences with IP/IPng and RSVP", see paragraph 3-4, page 1921 --	1-2,5-6
A	IEIC TRANS. COMMUN., Volume E78-B, No 8, August 1995, Hiroshi ESAKI, "High Speed Datagram Delivery over Internet Using ATM Technology", see point 3 --	3-6

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International application No.

PCT/SE 98/00296

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	IEEE Network, Volume, Sept. 1983, Lixia Zhang et al, "RSVP: A New Resource ReSerVation Protocol" --	1-6
A	GLOBECOM, Volume 1, 1995, Koohong Kang et al, "A CAC SCHEME FOR HETEROGENEOUS TRAFFIC IN ATM NETWORKS TO SUPPORT MULTIPLE QoS REQUIREMENTS" page 422 - page 423 --	3-6
P,A	EP 0790751 A2 (LUCENT TECHNOLOGIES INC.), 20 August 1997 (20.08.97), page 8, figures 4a-e, claims 1-8, abstract -- -----	1-6

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

30/06/98

International application No.

PCT/SE 98/00296

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